

“Distributed Utility Integration Test”

Subcontract Number: ZAT-3-32616-03

Distributed Utilities Associates

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Electric Distribution Transformation Program

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Goal

- **The Goal of the DUIT Project is to advance the state of the art in distributed generation and storage integration practices and strategies**
 - Accelerate the market growth of DER
 - Leading to lower ratepayer cost of service
 - Improve energy service, quality and reliability



The Objectives of the DUIT project are:

- To measure the interaction between DER and the distribution system and define metrics to quantify the benefits of the integration of diverse distributed generation and storage technologies in a distribution system
- to provide a testing ground for observing and measuring the interactions among the distributed technologies on the distribution system.
- to make the results of such credible activities publicly available

(Evaluate electrical implications from the high penetration and diversity of distributed resources on the utility distribution system)

- *Examine large numbers of units*
- *Examine diverse technologies*
- *Examine diverse situations)*



Statement of the Problem

- End-users are expecting traditional and emerging technologies can interconnect to the utility distribution system and all work together seamlessly, to provide the desired mixture of benefits
- Utilities are concerned about the effects of diverse DER and levels of penetration on the distribution system. Some utilities are also seeking evidence that DER can be used to improve system operation and lower the cost of electric service
- Technology developers expect DUIT to provide a vehicle for demonstrating the ability to interconnect and interoperate, and the safety, reliability, and other benefits of their equipment to endusers, utilities and regulators. Confidence by these bodies would potentially remove significant barriers to the wide-scale adoption and implementation of DER technologies
- Regulators require confidence as they consider adopting standardized interconnection procedures and seek evidence that DER can be used to improve distribution system operation and lower the cost of electric service, whether owned or operated by utilities, customers, or third parties



Approach

- Develop team
- Design and build a facility
- Develop testing regimen
 - Build consensus and prioritize tests
- Collect data
- Analyze data
- Present results



Collaboration and Leveraging (DUI) Participants

Capstone Turbine

Caterpillar

California Energy Commission

Cummins

Distributed Utility Associates

Encorp

Endecon Engineering

EPRI

Exelon (PECO)

GE

Magnetek

NREL/DOE

Powerlight

PG&E

Salt River Project

San Francisco PUC

SMA

SMUD

Solar Turbines

Southern Company

Texas PUC

United Technologies

Underwriters Labs

Xantrex



Progress to Date

- Test Plan 08/2002
- 2003 Based on Cost Shared Activities
- Facility Dedication 08/2003
- Anti-Islanding Testing 09/2003



DUIT Test Plan Protocols

Each protocol represents multiple tests across DR devices

Abnormal Conditions

Adjacent Feeder Faults

Anti-islanding

Capacitor Switching

Cold Load Pick-up

Control Strategies

Fuse Coordination

Network Systems

Power Quality

Reclosing Coordination

Synchronization

Short Circuit Current

Stability

Substation Backfeed

Sectionalizer Test

Voltage Regulation

Anti-islanding tests identified as having highest priority for Phase 1 of the DUIT testing



The MGTF Building



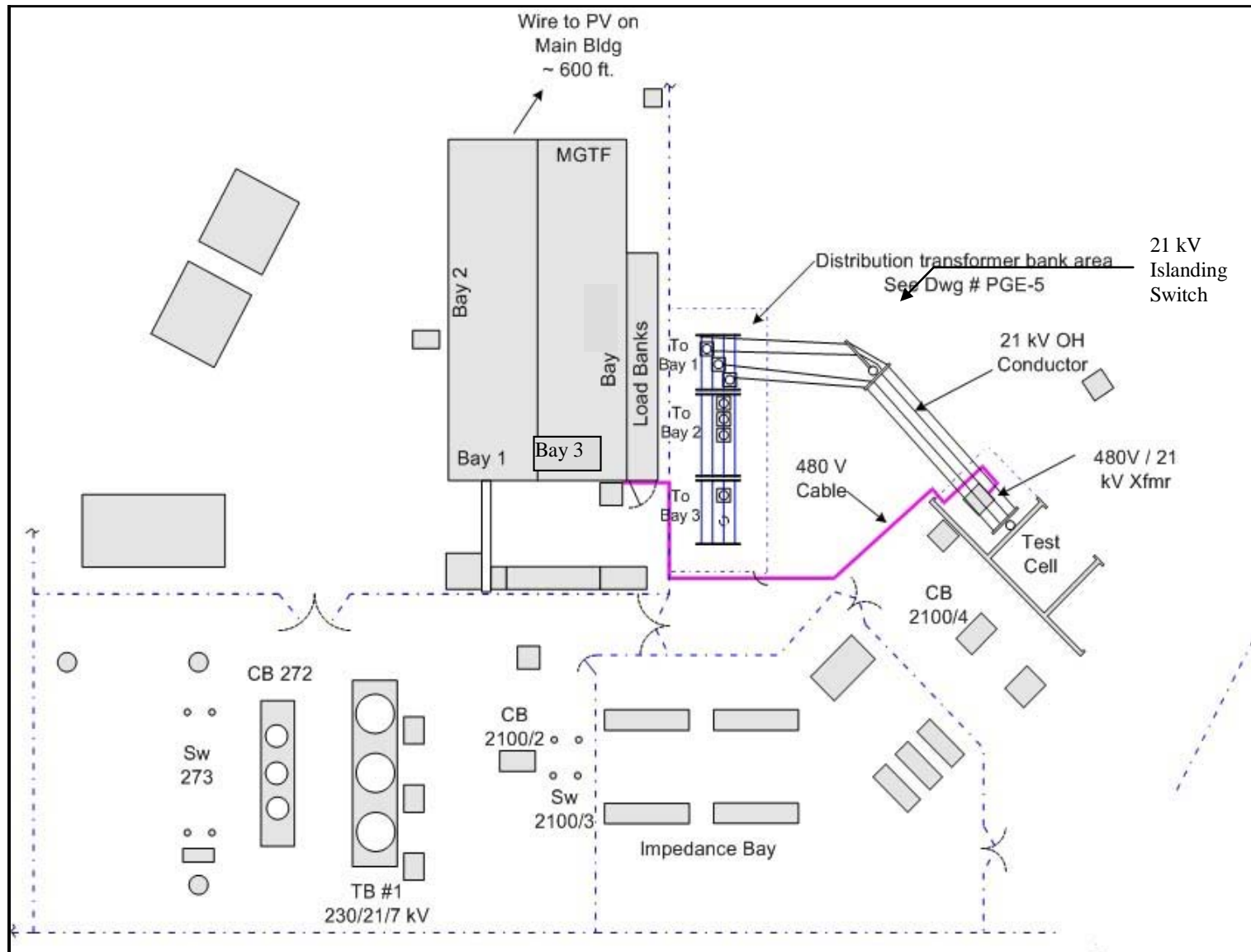


High Current Yard



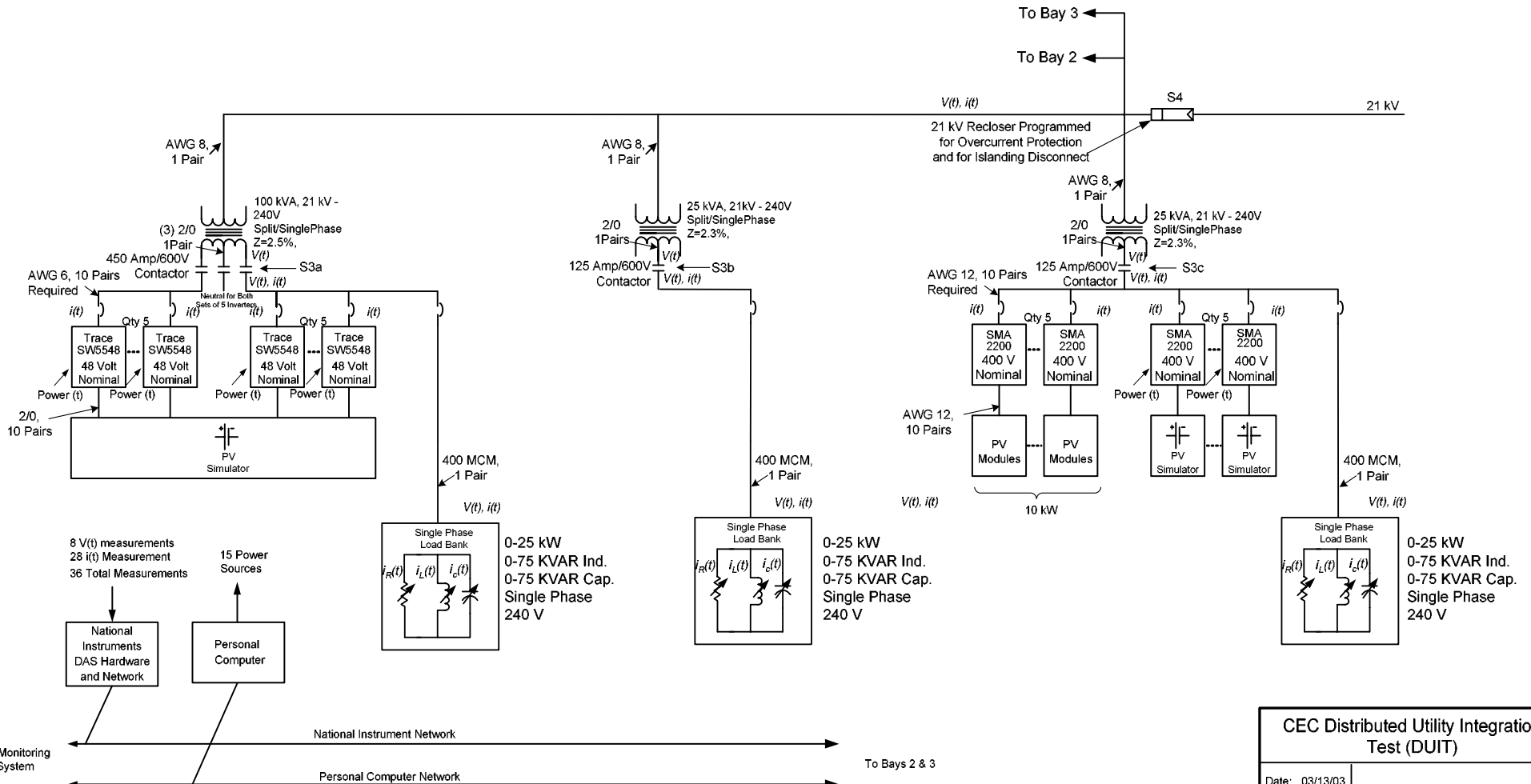


DUIT Test Facility - General Layout





Bay 1



CEC Distributed Utility Integration Test (DUIT)

Date: 03/13/03
Dwg. #: PGE-1
Rev. #: E
Drawn: WLE
Approved:

PG&E Modular Generation Test Facility (MGTF)

Bay 1 Configuration for CEC Testing



View of Bay 1

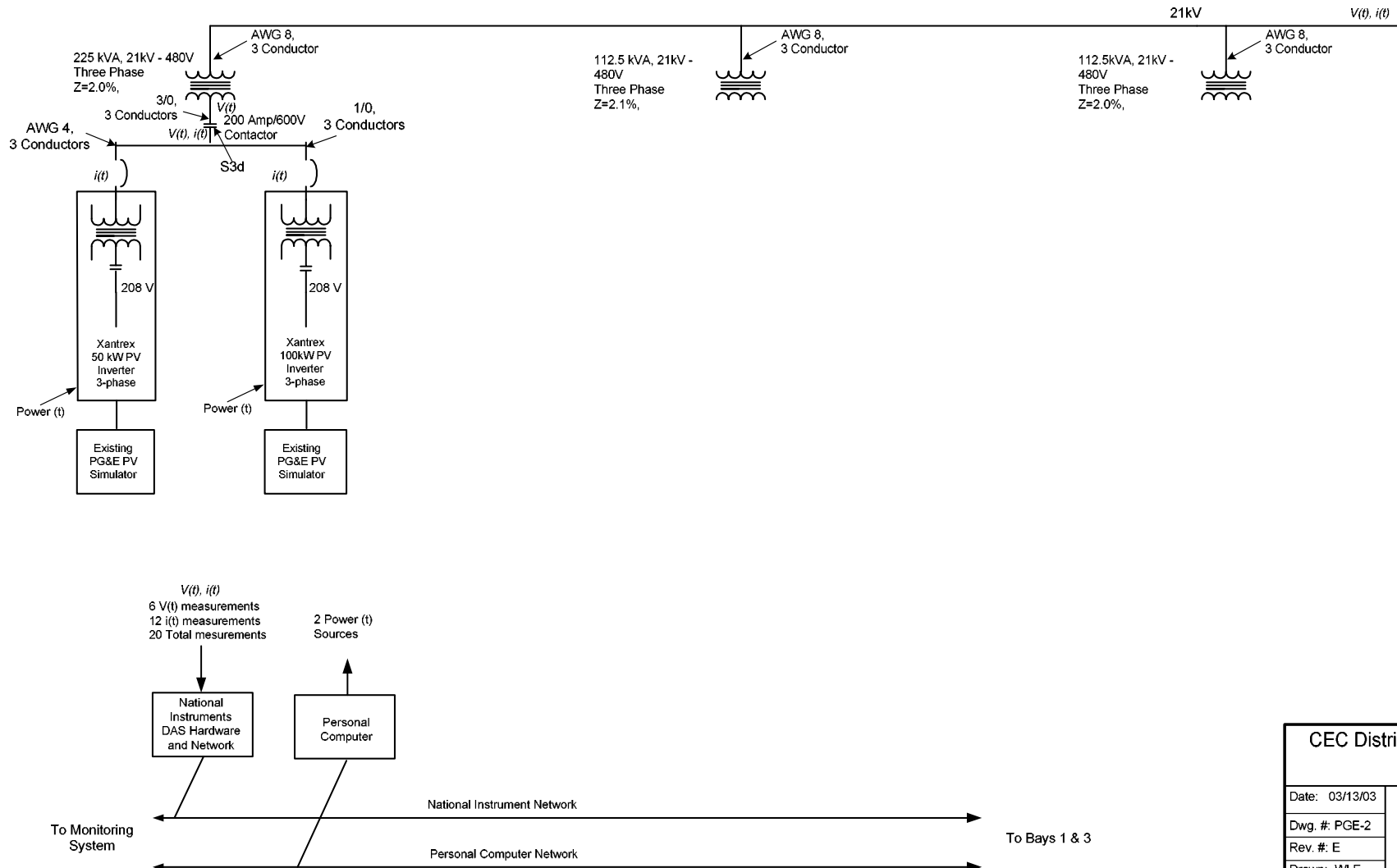




ELECTRIC DISTRIBUTION TRANSFORMATION PROGRAM



Bay 2



CEC Distributed Utility Integration Test (DUI)

Date: 03/13/03

Dwg. #: PGE-2

Rev. #: E

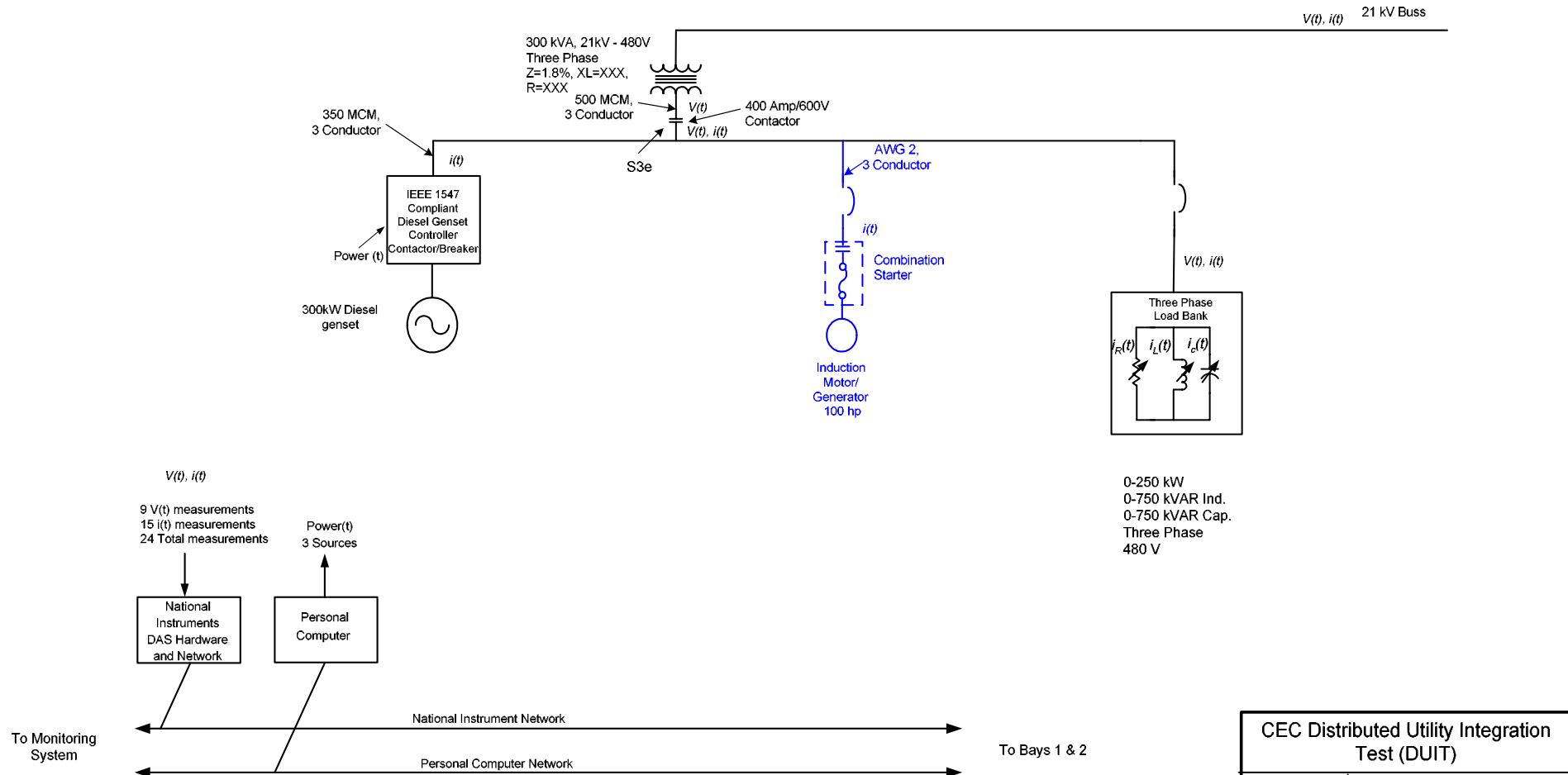
Drawn: WLE

Approved:

PG&E Modular Generation Test Facility (MGTF)
Bay 2 Configuration for CEC Testing



Bay 3



CEC Distributed Utility Integration Test (DUI)

Date: 03/13/03

Dwg. #: PGE-3

Rev. #: E

Drawn: WLE

Approved:

PG&E Modular Generation Test Facility (MGTF)

Bay 3 Configuration for CEC Testing



Challenges Encountered

- Funding and timing of funding
 - Financial positions of partners
- Building consensus
 - Takes time to bridge divergent views
 - Repetitive
- Coordination of testing methods
- Coordinating modeling and testing to reduce testing time



Current Phase 2002-2003 Budget and Funding Sources

CA Energy Commission	\$2,050,000
PG&E	\$ 285,000 + \$100,000
DR Vendors	\$ 200,000
NREL	\$ 500,000 +\$1,000,000 (FY:05-06)
SFPUC	\$ 50,000
DUA/Endecon	\$ <u>16,000</u>
Total	\$3,201,000

Total DUIT Budget requires \$10million over 7- 9 years



NREL BUDGET SUMMARY

Cost Element	FY04 (\$K)	FY05 (\$K)	FY06 (\$K)
Labor	\$170,000	\$220,000	\$200,000
Travel	\$15,000	15,000	15,000
Subcontracts	\$270,000	\$262,000	281,000
Other Costs	5,000	2,500	2,500
TOTAL	\$500,000	\$500,000	500,000



FY03 Progress and Accomplishments -Publications

- Systems Characterization, Distribution Impacts, and Operational Field Testing
 - “DUIT: Distributed Utility Integration Test”, NREL/SR-560-34389, August 2003



Planned Activities for FY04

- **Conduct Network Workshop in San Francisco**
- **Develop network testing protocols**
- **Upgrade facility to 7MVA**
- **Upgrade DAS and control system**
- **Complete Anti-Islanding testing 6.1-6.7***
- **Modeling to complement testing**



Anti-Islanding Test Plan	Test Description and Sequence
6.1	<i>Basic Islanding Test</i> Individual unit testing
6.2	<i>Islanding with Multiple DRs</i> Homogeneous Groups Small Groups Progressions
6.3	<i>Non-Linear Loads, Anti-islanding Tests</i> Individual Units
6.4	<i>Islanding with Dynamic Load:Generation Ratios</i> Individual Units
6.5	<i>Anti-islanding with Rotating Loads</i> Individual Units
6.6	<i>Harmonic Content due to Anti-islanding Schemes</i> Individual Units
6.7	<i>Voltage/Frequency Trip Settings</i> Individual Units Homogeneous Groups Small Groups Progressions



Summary of Outyear Activities

- **Radial system testing beyond anti-islanding**
 - **Testing high penetrations on the 7MVA feeder**
- **Test control system strategies**
- **Develop test plan for spot and secondary network testing**
 - **Build a network**



Impacts and Benefits on electricity affordability/reliability and infrastructure security/resilience, from implementation of project advancement

- **End-users can interconnect to the utility distribution system seamlessly, to provide the desired mixture of benefits**
- **Utilities understand the effects of diverse DER and levels of penetration on the distribution system**
- **DER can be used to improve system operation and lower the cost of electric service**
- **Technology developers demonstrate the ability to interconnect and interoperate, and the safety, reliability, and other benefits of their equipment to customers, utilities and regulators**
- **Regulators are confident about adopting standardized interconnection procedures and DER can be used to improve distribution system operation and lower the cost of electric service, whether owned or operated by utilities, customers, or third parties**



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